B/CS Unified Design Guideline Manual

Water, Sewer, and Streets

Effective August 4, 2000

Revised : 2006

BRYAN / COLLEGE STATION

UNIFORM DESIGN GUIDELINES

Domestic Water

Sentences and/or paragraphs that are double underlined indicate revisions that were made from the 2005 manual.

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GENERAL:

The purpose of this manual is to establish certain minimum criteria for the design of water distribution mains in the Cities' jurisdiction. It is intended to be used by the city staff and private consulting engineers for all new utility construction, replacements and modifications to the existing systems. Unusual circumstances or special designs requiring exception from the standards in this manual must be approved by the City Engineer.

This manual is intended to be used in conjunction with all current American Water Works Association (AWWA) and Texas Commission on Environmental Quality (TCEQ) requirements. Additionally, all design should be in accordance with the adopted version of the International Fire Code. In the case of a conflict between this manual and either or both of these other requirements, the most restrictive will govern.

The criteria outlined in this manual are also intended to be used in conjunction with the Cities' Unified Technical Specifications.

For the purpose of this manual, water distribution mains are those mains of 12 inches in diameter or smaller. Larger diameter mains are considered to be transmission mains and are subject to additional design criteria and review.

Submittal Requirements

The design engineer shall submit the following information with all water system designs:

- Plan and profile sheets containing all information necessary to review, construct and inspect the improvements. This shall include a traffic control plan as applicable

- Water Design Report showing that the design of the proposed improvements meets the requirements of this manual (such as fire flows, pressure, maximum run lengths, velocities, etc.)

- Copy of information provided to TCEQ in compliance with TCEQ submittal requirements (TAC290) for City records purposes. If the project is exempted from TCEQ submittal, this submittal to the City is also exempted.

- Certification that plans meet all requirements except where noted.

Special Designs

The City Engineer may, upon request, approve an alternative design or construction methodology that differs from the requirements in this manual if the City Engineer determines that: (1) the alternative design or construction methodology is equivalent to, or superior to, the methodology required in this manual, and (2) the alternative design or construction methodology is sufficient to ensure public health and safety.

Connections

All connections and service leads shall be installed to both sides of all roads and alleys at the time of main line installation.

Service connections to 16" or larger water mains shall not be allowed.

PIPE SELECTION:

Pipes shall be selected, sized and designed to provide a safe, efficient and maintainable system for the conveyance of domestic water from existing supplies and systems to new or existing users.

Pipe Materials

The following pipe materials may be specified for water distribution mains:

Ductile iron pipe (DIP) per ANSI/AWWA C151/A21.5 pressure class 350 for sizes 6 through 12 inches, pressure class 250 for 18 inch, and pressure class 200 for 24 inches and greater. Where excessive depths are encountered (greater than 10 feet), the design engineer shall specify an appropriate thickness class to be approved by the City Engineer.

Polyvinyl chloride pipe (PVC) shall be SDR-21, ASTM D2241 pressure class 200 for 3 inch; pressure class 200 DR14 (meeting AWWA C-909 standards) for sizes 6 through 12 inches; and pressure class 235 DR 18 (meeting AWWA C-905 standards) for pipe sizes greater than 12 inches. PVC pipe will not be permitted for aerial crossings. DI fittings shall be used with PVC pipe. Fittings shall be wrapped with eight-mil polywrap and sealed on the edges with an approved tape.

Type 'K' copper tubing shall be used for all service lines 2 inches and smaller.

Changes in pipe material shall only occur at valves or fittings with the exception of short replacements of water lines needed to meet TCEQ separation requirements.

For material information on pipe encasements refer to "Encasements" on Page 8.

Pipe Sizing

Pipes and pipe systems shall be designed to provide the service criteria listed below.

Standard Pipe Sizes

The standard pipe sizes for water distribution mains are 3, 6, 8, 10, 12, 16, and 18inches in diameter. As discussed in the "Maximum Lengths for Water Mains" Section, the smaller lines have restrictions for use. Standard size service lines within the right of way shall be 1, 1½, or 2 inch.

Looping Requirements

Permanent dead-end mains will not be allowed if looping alternatives are available. This may require extending the water lines beyond project limits.

Dead-end mains will be allowed at ends of cul-de-sacs where the only alternative is to loop lines down side lot lines in residential subdivisions. It is preferred to use 3 inch diameter lines where the maximum length as described in the following section is not exceeded.

Fire Suppression Service Line

Fire suppression service lines shall be private lines. An isolation valve, locked in an open position, shall be installed on the fire suppression service line and shall be maintained by the City. Fire suppression service lines shall not be tapped for service and shall be designed and constructed in accordance to these guidelines.

Maximum Lengths for Water Mains

A 3 inch line may be allowed for permanent dead-end mains not exceeding 500 feet. A 6 inch main may be allowed up to a maximum of 1500 feet in length and must connect at each end to an 8 inch or larger main and shall have no more than 2 fire hydrants or flushing points. Where it is not possible to meet this requirement, a 6-inch main may be extended to a maximum of 800 feet in length and shall terminate with a fire hydrant or blow-off assembly.

TCEQ rules shall dictate the number of services allowed on the smaller sized line.

Pressure/Flow Requirements

Water distribution mains shall be sized to meet all of the following requirements using a Hardy-Cross based analysis method or methods encompassed in software packages such as KY-Pipe, MikeNet, or Cybernet.

Design Flow Calculation

Both normal and fire flows are needed for meeting the design criteria as established under Design Flow Calculation and System Design Criteria.

Normal Flow

One of the following three methods shall be used to determine the normal flows by which the water system is to be designed.

Peak Hourly Flow = (Average Daily Flow)(4)

- Method 1 – Fixture Count Determination

  The "fixture unit" method of estimating ***peak*** water demand may be used in accordance with the current duly adopted City Plumbing Code.

- Method 2 - Land Use Determination

  Table I contains the normal flow demands that are expected from a variety of uses.

  The population factor for residential land uses is 2.67 persons per unit, which is then applied to the actual number of units per acre, if known, or the maximum units per acre from the current land use plan if the property development is not yet finalized.

The population factors for non-residential uses are 30 persons per acre for commercial, office and institutional uses and 15 persons per acre for Industrial uses.

- Method 3 - Gross Area Determination

  In the absence of projected land uses, the demands contained in Table II may be used.

Fire Flows

For the purposes of this manual, the following shall be used for fire flow determinations unless greater flows are required for hydrants near structures as per the adopted International Fire Code.

- *Residential* — 1000 gallons per minute for public hydrants in single family or duplex residential areas
- *Commercial* — At least 2500 gallons per minute for public hydrants shall be in commercial or multi-family areas (this flow may be split between two adjacent fire hydrants within 600 feet of each other). At the time that the site is developed, fire flows shall be as per the adopted Fire Code.
- *Other/Hi-Rise* — For onsite fire hydrants needed to obtain coverage of commercial or other high density uses, the design engineer shall consult the City Fire Marshal to obtain the specific fire flow demands for each project via the International Fire Code.

Fire Flow System Design Criteria

The following criteria shall be met on all new water improvements.

- Under normal conditions, provide residual pressures in the area serviced by the system improvement to meet TCEQ requirements, and at all times a minimum static pressure of 35 pounds per square inch (psi).
- Under fire flow conditions, provide the required fire flow at the most hydraulically remote pairings of 2 adjacent fire hydrants in the system improvement in addition to the peak hourly flow. A residual pressure of no less than 20 psi is required.

- Provide maximum velocities of not more than 12 feet per second (fps) during fire flow in both existing and proposed mains. This maximum velocity may be increased on a case by case basis depending on the condition of the existing mains and if an engineering evaluation has been performed.

- Conform to any area wide master plans, including over sizing for future development.

Fire Flow Testing

All fire flow testing shall be in accordance to the National Fire Prevention Association (NFPA) Standard No. 291, Chapter 4. A hydrant flow test report must be submitted with Engineer's report.

PIPE ALIGNMENT:

The design of water distribution mains should provide for economical access for maintenance and repair, reliability of location and minimum disruption to surrounding facilities during repair operations. In all cases water facilities shall comply with TCEQ separation requirements.

Horizontal Layout

The centerline of water distribution mains constructed in street rights-of-way shall remain parallel to the right-of-way line when possible. Where possible, avoid placing water line fittings and connections under paved and fenced areas.

The City may require the location of a proposed water main within a site to be revised based upon proximity to any existing or proposed buildings. Where possible water lines should be located at least 15 to 20 feet away from structures, however size and depth of proposed water line may increase this distance.

Vertical Layout

Water distribution mains should be laid to as straight a grade as possible between cross street connections. Vertical alignment should avoid high or low points between connections. (See Flushing Design below)

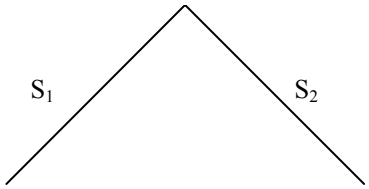
All water distribution mains 12 inches in diameter and smaller shall have a minimum cover to finished surface of 4 feet. Mains greater than 12 inches in diameter shall have a minimum cover of 5 feet to finished surface.

Flushing Design

Water distribution mains should have a means of a minimum cleaning velocity of 5 fps. Additionally, fire hydrants shall be placed close to low point as practical.

Air relief valves and flushing appurtenances shall be placed at critical locations including an air release valve at all peaks for lines 12" and larger and on smaller lines where the peak has an "A" of 10 or more.

$$A = | (S_1) - (S_2) |$$



All dead end lines shall be designed to allow adequate flushing capability. A flushing assembly shall be provided for all lines. Provisions for flushing shall be provided at critical low areas along the line.

Main Size	Blow-off
3"	2"
6"	2"
8"	2"
10"	4" or Fire Hydrant
12"	4" or Fire Hydrant
16"	4" or Fire Hydrant
18"	4" or Fire Hydrant
≥24"	6"

Deflections, Bends and Curves

The maximum deflection of pipe is to be restricted as shown in Table III. Deflection for PVC pipe shall be made along the pipe barrel and not at the joint, while ductile iron pipe shall be deflected at the joints. Service connections should be limited in curved sections of pipe.

All bends and fittings shall have restrained joints and shall be blocked to undisturbed soil. Use 2 - 45° bends in lieu of a 90° bend whenever possible.

Curvature of pipe shall be accomplished through multiple, spaced deflections as described above. The minimum radius of curvature for water pipes is shown in Table III.

Separation from

Separation of public water and wastewater mains will be

Wastewater Facilities

consistent with the current Rules and Regulations for Public Water Systems of the TCEQ.
Separation of public water and wastewater mains from other underground utilities (storm, gas, etc.) shall be a minimum of 2 feet longitudinally.

VALVES :

All mainline valves 12" in diameter or less shall be gate valves whereas valves in lines greater than 12 inch may be butterfly valves or resilient gate valves.

Location and Spacing

A valve should be located:

- One (1) less than every leg of a cross connection.
- At the end of temporary dead-end lines, within 70 feet from the end of the line for lines greater than 8" and within 200 feet for lines equal to and less than 8".
- At the end of a public line (unless there is a meter)
- On 2 legs of a tee connection.
- Every 800 feet.
- Where possible, place valves in green areas and avoid handicap ramps.

A valve will be required at the point of connection of a new main extending an existing main unless the existing main has an in-line valve within 200 feet of the connection.

Valves shall be placed at intervals not to exceed 800 feet regardless of the distance between intersections. Wherever possible, they shall be located within 5 feet of a fire hydrant. The City Engineer may require additional valves to prevent unnecessary disruptions of service. Fire hydrant lead valves are to be positively anchored to the main line.

Valves are to be located so that no more than 4 valves are required to isolate a section of main.

Tapping Sleeves

Tapping Sleeves and valves will be allowed unless size on size connections are needed, and then Tee connections will be required on City owned water systems. A Tee connection may also be required where main line valves are needed.

FIRE HYDRANTS:

Fire hydrants are to be located at street intersections or as close to an intersection as possible. Hydrants should not be located within the intersection curb return radius. Intermediate fire hydrants should be located near property line extensions and no closer than 5 feet to any service line.

In accordance with TCEQ, fire hydrants shall not be placed closer than 9 feet horizontally and vertically from any wastewater main or appurtenance. All fire hydrants shall be connected to a minimum 6 inch water main.

If it is necessary to place a fire hydrant in a proposed sidewalk location, the sidewalk shall be widened or relocated to maintain the required sidewalk width.

Fire hydrants shall be placed within 150 feet of a fire department connection on the structure as per the adopted Fire Code.

Residential Fire Hydrants

In residential areas fire hydrants should be placed within the right-of-way in the vicinity of the common lot lines.

Public fire hydrants shall be spaced 1000 feet apart in single-family districts at locations so that structures (or undeveloped lots) shall not be more than 500 feet from a fire hydrant as measured along the right of way of a public street as the fire hose is laid off the fire truck.

In residential areas with lots sizes of 5 acres or greater, fire hydrants may be spaced at 1,500 feet along the water main so that structures shall not be more than 750 feet from a fire hydrant as measured along the right of way of a public street as the fire hose is laid off the fire truck.

Non-Residential Fire Hydrants

Public fire hydrants in districts other than single family districts shall be installed as per the Cities Fire Codes.

Upon approval by the City Engineer, the installation of some or all public fire hydrants in such districts may be deferred and required as a condition of the building permit(s) for structures.

CROSSINGS:

Water distribution mains that cross state highways must conform to the Cities' Unified Technical Specifications and the requirements of the Texas Department of Transportation (TxDOT). Mechanical bores are required for all crossings of existing streets.

Water distribution mains that cross railroads must conform to the Cities' Unified Technical Specifications and the requirements of the railroad company whose right-of-way is being crossed.

For water distribution mains crossing creeks or drainage channels regulated by FEMA, shall require encasement. Below grade crossings are preferred; however aerial crossings may be considered. Thrust restraint shall be provided at points of transition from buried to exposed pipe and at changes in alignment of exposed pipe. Air release valves shall be provided at the high point of all crossings.

Below grade crossings of creeks and drainage channels shall have a minimum cover of 3.5 feet below the flowline at the time of construction. All below grade crossings will require encasement with steel encasement pipe and all ends shall be capped and sealed. The casing shall be carried into the bank a distance that should consider changes in the creek channel. This distance would usually be beyond the high bank such that if you measured a 1:1 slope from the high bank away from the channel, the casing would terminate at that location.

ENCASEMENT:

Steel cylinder pipe shall be used for all encasement pipe. Other encasement pipe material may be used per TCEQ requirements and City specifications. Carrier pipes sized 30 inches or less shall use an encasement pipe with a wall thickness of no less than 3/8-inch. For larger carrier pipes, a wall thickness of no less than 1/2-inch shall be used. Coating of encasement pipe may be required in special soil conditions.

Pipe encasement will be required for all water mains crossing any street classified as major collector and greater including new streets regardless of method of installation. This does not apply to services. Special field conditions may require an alternate method of installation, which must be approved by the City Engineer.

The encasement pipe shall be sized in accordance with the Unified Technical Specifications and shall extend 2 feet beyond the back of both curbs on the street. Ends of encasement pipes shall be sealed to prevent the intrusion and collection of groundwater.

All carrier pipes will be supported by casing spacers in accordance with the specifications and details, and shall have joints restrained by an approved method that will allow the removal of the carrier pipe from the encasement pipe in a single direction by means of tension on the carrier pipe only.

EASEMENTS:

Water mains constructed outside of public rights-of-way shall be in easements of not less than 15 feet in width except for the following: if the water main bury is deeper than 6 feet the easement width shall be not less than 20 feet; and if the water main bury is greater than 14 feet, the easement width shall be 30 feet. If both water and wastewater mains are located within the same easement, the width shall not be less than 30 feet (larger widths will be required depending on the depth of the sewer main). Where water lines will be adjacent to building structures, easement width shall be increased.

The easement must be located such that the centerline of the waterline is no closer than 5.5 feet to the closest edge of the easement.

Water mains constructed adjacent to TxDOT maintained roadways shall be located in the utility accommodation zone provided by TxDOT. If there is no utility accommodation zone, or if the zone is occupied, then the water line shall be installed in a separate easement (min. 15 feet) adjacent to the right-of-way.

TABLE I
AVERAGE WATER DEMANDS

USE	AVERAGE FLOW GPD / CAP
Residential	100
Commercial	
-Office	50
-Retail	25
-Hotel/Motel	150
Institutional	
-Schools	35
-Hospitals	200
Industrial	50

TABLE II
NORMAL WATER DESIGN DEMANDS

TRIBUTARY AREA (Acres)	DESIGN DEMAND (g.p.d. per acre)
Less than 250	7000
250-300	6500
300-500	5500
500-1500	5000
1500-3000	4500
More than 3000	4000

TABLE III
MINIMUM RADIUS FOR WATER PIPE

SIZE	PVC – CLASS 200 (20-ft. Joint)	DUCTILE IRON (18-ft. Joint)
6-IN	220 ft	400 ft
8-IN	400 ft	400 ft
12-IN	600 ft	400 ft

BRYAN / COLLEGE STATION

UNIFORM DESIGN GUIDELINES

Sanitary Sewer

Sentences and/or paragraphs that are double underlined indicate revisions that were made from the 2005 manual.

Table of Contents

GENERAL:

The purpose of this manual is to establish certain minimum criteria for the design of wastewater collection mains in the Cities' jurisdiction. It is intended to be used by the city staff and private consulting engineers for all new utility construction, replacements and modifications to the existing systems. Unusual circumstances or special designs requiring exception from the standards in this manual must be approved by the City Engineer.

This manual is intended to be used in conjunction with all current American Water Works Association (AWWA) and Texas Commission on Environmental Quality (TCEQ) requirements. In the case of a conflict between this manual and either or both of these other requirements, the most restrictive will govern.

The criteria outlined in this manual are also intended to be used in conjunction with the Cities' Unified Technical Specifications.

For the purpose of this manual, wastewater collection mains are those mains of 18 inches in diameter or smaller. Larger diameter mains are considered to be interceptor or transmission mains and are subject to additional design criteria and review.

Proposed wastewater collection systems that accept flows from existing upstream sewers shall be designed to accommodate all flows generated by the upstream service area. The existing upstream sewers may experience variable peak flows greater than the peaks utilized in the design of new sewers. The peak flow rates (particularly the infiltration/inflow rates) for each existing subsystem is highly variable. Consult with the City Engineering Services Department to confirm the proper peak flow rates to be used for any existing upstream wastewater collection system. The proposed wastewater collection system design shall include a review of all existing downstream sewers receiving flow from the proposed sewers to verify that flows generated from the proposed wastewater collection system do not adversely affect the performance of the downstream systems.

Submittal Requirements

The design engineer shall submit the following information with all wastewater system designs:

- Plan and profile sheets containing all information necessary to review, construct and inspect the improvements. This shall include a traffic control plan as applicable
- Wastewater Design Report showing that the design of the proposed improvements meet the flow requirements of this manual.
- Copy of information provided to TCEQ in compliance with TCEQ submittal requirements (TAC317) for City records purposes. If the project is exempted from TCEQ submittal, this submittal to the City is also exempted.
- Certification that plans meet all requirements except where noted.

Special Designs

The City Engineer may, upon request, approve an alternate design or construction methodology that differs from the requirements in this manual if the City Engineer determines that: (1) the alternative design or construction methodology is equivalent to, or superior to, the methodology required in this manual, and (2) the alternative design or construction methodology is sufficient to ensure public health and safety..

Lift station design shall follow acceptable engineering practices and be reviewed by City staff.

Connections

All residential connections and service leads shall be installed to both sides of all roads and alleys at the time of main line installation. Four (4") inch standard service leads shall not be more than 150 feet in length.

Service connections shall be tied into the main line. Service connections do not require a manhole at point of connection. Should the service tie into a manhole, the service shall be close to the flow line or a drop should be installed in accordance with TCEQ Ch. 317.2

PIPE SELECTION: Pipes shall be designed to provide a safe, efficient and maintainable system for the collection of wastewater from its various sources of generation to the existing collection and interceptor systems.

Pipe Materials

The following pipe materials may be specified for wastewater, collection, and force mains within the City's rights-of-ways.

Ductile iron pipe (DIP) per ANSI/AWWA C151/A21.5 pressure class 350 for sizes 6 through 12 inches, pressure class 250 for 18 inch, and pressure class 200 for 24 inch and greater. Force mains shall be DIP, pressure class 350 or ASTM D2241 pressure class 160 and shall not be greater in size than 8 inches.

Polyvinyl chloride pipe (PVC) and all fittings shall be SDR26-ASTM D3034 in sizes 6 through 12 inches and SDR26-ASTM F679 for larger sizes. PVC pipe will not be permitted for aerial crossings.

For material information on pipe encasements refer to the "Encasements" section of this document.

Changes in pipe material shall only occur at manholes with the exception of short replacements of sewer lines needed to meet TCEQ separation requirements.

Pipe Sizing

Pipes and pipe systems shall be designed to provide the service criteria listed below.

Standard Pipe Sizes

The standard pipe sizes for wastewater collection mains are 6, 8, 10, 12, and 18 inches in diameter.

Minimum Pipe Sizes

Minimum wastewater pipe sizes shall be as follows:

- Collection Mains – 6 inches
- Residential Service Leads – 4 inches (single & double)
- Commercial Service Leads – 6 inches (single or double when capacity is shown to be adequate)
- Duplex lots shall have a double 4" service per lot or a double service per two lots with a 6 inch service line.

Flow Requirements

Wastewater collection mains shall be sized to meet all of the following requirements using an analysis method based on Manning's equation.

Flow Calculation

One of the following three methods shall be used to determine the peak hourly flows by which a new wastewater system at the fringes of the existing system is to be designed (For new systems being developed within the existing system, consult the Wastewater Master Plan for design criteria). In each method, the following equations apply:

Peak Hourly Flow = (Average Daily Flow)(4)

- Method 1 - Fixture Count Determination

  For multi-family residential, institutional, commercial and industrial uses, the "fixture unit" method of estimating peak wastewater generation may be used in accordance with the current duly adopted City Plumbing Code. Table I shows a fixture unit value for various plumbing fixtures and groups of fixtures. Table II shows the probable peak rate of flow generation from systems consisting of various numbers of fixture units.

- Method 2 – Land Use Determination

  Table III contains the average daily flow per capita to be expected from a variety of uses.

  The population factor for residential land uses is 2.67 persons per unit, which is then applied to the actual number of units per acre if known, or the maximum units per acre from the current land use plan if the property development is not yet finalized.

  The population factors for non-residential uses are 30 persons per acre for commercial, office and institutional uses and 15 persons per acre for Industrial uses.

- Method 3 – Historical Data

  If there is information regarding average daily flows for a particular type of development that is more accurate than the data from the other methods, the historic information may be used. Please discuss this with the City prior to using so as to ensure the information is acceptable.

System Design Criteria

Wastewater mains and collection lines shall be designed to carry the peak daily load estimated from the tributary areas when fully developed to the current land use plan. Determination of peak loadings shall be based on an analysis of the density and character of the land uses in the tributary area and the probable wastewater generation from those uses.

MINIMUM / MAXIMUM PIPE SLOPES

PIPE SIZE	SLOPE (%)	
	MINIMUM	MAXIMUM
6”	0.80	7.80
8”	0.40	5.30
10”	0.30	3.90
12”	0.25	3.10
18”	0.20	1.80
24”	0.20	1.20
30”	0.20	0.90
36”	0.20	0.70

For lines larger than 36 inches in diameter, the slope may be determined by Manning’s formula to maintain a minimum velocity greater than 2.5 feet per second when flowing full and a maximum velocity less than 8 feet per second when flowing full when using a Manning’s “n” of 0.013.

Pipe velocities should be consistent between manholes and avoid abrupt reductions in velocity.

PIPE ALIGNMENT:

The design of the wastewater collection mains should provide economical access for maintenance and repair, reliability of location and minimum disruption to surrounding facilities during repair operations. In all cases wastewater facilities shall comply with TCEQ requirements.

Horizontal Layout

Wastewater mains and collection lines should be laid straight between manholes and at a uniform distance from the right-of-way line.

The centerline of wastewater mains and collection lines constructed in street rights-of-way shall be located on the opposite side of the street from the water main. Where possible, avoid placing sewer under paved areas, especially manholes.

The City may require the location of a proposed sewer main within a site to be revised based upon proximity to any existing or proposed buildings. Where possible sewer lines should be located at least 15 to 20 feet away from structures, however size and depth of proposed sewer line may increase this distance.

Vertical Layout

The desired depth for sanitary sewer main shall be six feet (6') as measured from the outside top of pipe vertically to finished ground or pavement surface elevation. The minimum depth shall be two feet (2'). Where the cover is 3.5' or less, ductile iron pipe should be used and cement stabilized sand backfill required where erosion may occur.

Wastewater mains and laterals should be laid on a straight grade between manholes while avoiding excessive depths. Elevations must be shown on construction plans at 100-foot stations and at all manholes and match marks. Elevations are to be calculated to the nearest 0.01 foot.

Wastewater mains and collection lines must be constructed to a depth which will insure gravity flow in service connections to adjacent properties. In general, this is accomplished by setting a 2% (1% Min.) grade from the centerline of the collection main to a point one (1) foot below floor elevation at the building line of the structure being served. The service lead must have a minimum cover of 2 feet at its shallowest point including roadside drainage ditches where present.

Separation From Water Facilities

Separation of public water and wastewater mains will be consistent with the current Rules and Regulations for Public Water Systems of the TCEQ.

MANHOLES:

Manholes will be required at changes in horizontal alignment, changes in grade, changes in pipe size and junctions with other wastewater mains or collection lines. Manholes will not be required at the junctions where service leads join mains.

The maximum distance between manholes shall be as per the requirements of TCEQ.

When a change in the size of a wastewater main or collection line occurs without a change in grade, the inside top of pipe (soffit) elevations will be matched in the manhole. Elevation differences between pipes at a manhole may require a drop manhole (see TCEQ for more information).

A 0.1 foot drop through the manhole is desired.

At the end of a main or collection line, the line shall be terminated with a manhole or clean out as per TCEQ requirements. Clean-outs shall only be allowed when there is no physical means for an extension and the line is less than 4 feet in depth. If an extension is anticipated, a plugged stub-out of one full pipe joint with a clean-out is required.

Manholes may be constructed of fiberglass or concrete. Fiberglass manholes may only be used in non-structural areas as a special design.

Manhole sizes shall be as follows:

Manhole Diameter	Main Size
4 ft	<18 in.
5 ft	≥18 in. < 30 in.
6 ft	≥36 in.

RIGHT-OF-WAY CROSSINGS:

Wastewater collection mains that cross state highways must conform to the Cities' Unified Technical Specifications and the requirements of the Texas Department of Transportation (TxDOT).

Wastewater collection mains that cross railroads must conform to the Cities' Unified Technical Specifications and the requirements of the railroad company whose right-of-way is being crossed.

For wastewater collection mains crossing creeks or drainage channels, piers must support the elevated sections of such crossings.

Below grade crossings of creeks and drainage channels shall have a minimum cover of 3.5 feet below the flowline at the time of construction. All below grade crossings will require encasement with steel encasement pipe and all ends shall be capped and sealed. The casing shall be carried into the bank a distance that should consider changes in the creek channel. This distance would usually be beyond the high bank such that if you measured a 1:1 slope from the high bank away from the channel, the casing would terminate at that location. If the pipe is less than 3.5 feet in depth, concrete encasement shall be considered.

Dry bore all crossings of existing streets unless otherwise authorized by the City Engineer.

ENCASEMENTS:

Steel cylinder pipe shall be used for all encasement pipe. Other encasement pipe material may be used per TCEQ requirements and City Specifications. Carrier pipes sized 30 inches or less shall use an encasement pipe with a wall thickness no less than 3/8-inch. For larger carrier pipes, a wall thickness of no less than 1/2-inch shall be used. Coating of encasement pipe may be required in special soil conditions.

Pipe encasement will be required for all wastewater collection mains crossing any existing street and on new streets classified as major collector or greater. This does not apply to services. Special field conditions may require an alternate method of installation, which must be approved by the City Engineer.

Encasement pipe diameter shall be as specified in the Technical Specifications. Encasement pipes shall extend 2 feet beyond the back of both curbs on the street. Ends of encasement pipes shall be sealed to prevent the intrusion and collection of groundwater.

All carrier pipes will be supported by Cascade carriers (or approved equal), that will allow the removal of the carrier pipe from the encasement pipe in a single direction by means of tension on the carrier pipe only.

EASEMENTS:

Wastewater lines constructed outside of or not adjacent to public rights-of-way shall be in easements of not less than 15 feet in width except for the following: if the sewer main bury is deeper than 6 feet, the easement width shall be not less than 20 feet: and if the sewer main bury is greater than 14 feet, the easement width shall be 30 feet. If both wastewater and water mains are located within the same easement, the width shall not be less than 30 feet (larger widths will be required depending on the depth of the sewer main). Where sewer mains will be adjacent to building structures, easement width may be increased.

The easement must be located such that the centerline of the wastewater line is no closer than 5.5 feet to the closest edge of the easement.

Wastewater collection mains constructed adjacent to TxDOT maintained roadways shall be located in a utility easement. The main may be allowed within a utility accommodation zone provided by TxDOT on a case by case basis.

TABLE I
FIXTURE UNITS PER UNIT OR GROUP

FIXTURE TYPE	FIXTURE UNIT VALUE LOAD FACTOR
One Bathroom Group – tank operated water closet, tub or shower, lavatory	6
Bathtub (with or without shower)	2
Dishwater (domestic)	2
Kitchen Sink With food grinder	1 2
Lavatory	2
Shower Group, per head	3
Sinks, commercial -Surgeon's -Flushing Rim (with valve) -Service -Pot (scullery, etc.)	 3 8 3 4
Urinals	4
Washer, clothes	4
Water Closets -Tank Operated -Valve Operated	 4 8

TABLE II
PEAK WASTEWATER FLOWS BASED ON FIXTURE UNITS

FIXTURE UNITS	PEAK DEMAND (GPM)
500	125
1000	215
1500	300
2000	330
2500	380
3000	420
3500	490
4000	560
4500	630
5000	700
6000	840
7000	980
8000	1120
9000	1260
10000	1330

TABLE III
AVERAGE WASTEWATER GENERATIONS

USE	AVERAGE FLOW GPD/CAP
Residential	100
Commercial	
-Office	50
-Retail	25
-Hotel/Motel	50 *
-Restaurants	600 GPD/1000 SF
Institutional	
-Schools	35
-Hospitals	200
Industrial	50

* Does not include restaurants or other ancillary

BRYAN / COLLEGE STATION

UNIFORM DESIGN GUIDELINES

Streets and Alleys

Sentences and/or paragraphs that are double underlined indicate revisions that were made from the 2005 manual.

Table of Contents

List of Tables

List of Figures

GENERAL:

The purpose of this manual is to establish basic guidelines and certain minimum criteria for the design of streets and thoroughfares in the City. It is intended to be used by the city staff and private consulting engineers for all new street construction and improvements to existing streets. Unusual circumstances or special designs requiring exception from the standards in this manual must be approved by the City Engineer.

The criteria outlined in this manual are also intended to be used in conjunction with the Typical Construction Details and the Typical Specifications for Public Works Construction utilized by the City.

The geometric design policies contained in this manual are intended to provide a reasonable degree of safety to users of the public rights-of-way in normal weather and traffic conditions. The minimum design criteria for pavement structure are intended to produce streets having a useful life expectancy of at least 20 years with reasonable expenditures for maintenance and repair.

Submittal Requirements

The design engineer shall submit the following information with all street designs:

- Plan and profile sheets containing all information necessary to review, construct and inspect the proposed improvements. This includes, but is not limited to, pavement markings, and signs on major collectors and greater. Topographical information outside of right-of-way should be provided where the information is available. For arterial streets, the design speed must be indicated for all horizontal and vertical curves.

- Drainage report in accordance with the City's Drainage Design Guideline Manual.

- Traffic Control Plans detailing the safe and efficient operation of traffic through the work zone during construction. These plans shall be prepared in accordance with the latest edition of the Texas Manual on Uniform Traffic Control Devices (TMUTCD).
- Certification that plans meet all requirements except where noted.

Special Designs

The City Engineer may, upon request, approve an alternative design, unusual circumstance, or construction methodology that differs from the requirements in this manual on a case by case basis if the City Engineer determines that: (1) the alternative design or construction methodology is equivalent to, or superior to, the methodology required in this manual, and (2) the alternative design or construction methodology is sufficient to ensure public health and safety. For unusual circumstances or special designs not covered in this manual refer to the latest edition of American Association of State Highway and Transportation Officials (AASHTO), "*A Policy on Geometric Design of Highways and Streets*".

STREET CLASSIFICATIONS:

The City has adopted a functional street classification system, which basically categorizes all streets as rural, residential, collector and arterial streets. Table III defines the design criteria for all proposed streets by classification which are shown on Figures 1, 2 and 3. For classification of existing and proposed streets refer to Table IV.

GEOMETRIC CRITERIA:

The elements utilized in this manual to establish engineering design criteria are based on design vehicles traveling at design speeds over specified pavement widths. These elements then relate to design guidelines for horizontal curves, vertical curves, and the use of super-elevation. Intersection controls, driveway locations and many other factors may affect the design as well.

Selected minimum criteria are listed in Tables VI and VII. In most cases the criteria specified is the minimum allowed for general design; however specific locations and circumstances may warrant the use of more stringent criteria.

Design Vehicle

Two (2) design vehicle configurations are used to establish curve and intersection design controls as listed in the tables within these Guidelines. The characteristics of these vehicles are shown in Figures 4 and 5. For additional information, Figure 6 represents passenger car configurations for off-street parking. Figure 7 represents the City's Fire Services ladder fire truck.

Design Speed

Design speed is the designated speed used to determine curvature, super-elevation and sight distance criteria. The minimum design speeds for the various street classifications and widths are shown in the tables within these Guidelines.

Pavement and Lane Width

Refer to Table III for appropriate lane and pavement widths.

Where bicycle lanes are provided, they shall be constructed per Figures 2 and 3. The bike lane shall be delineated by a continuous painted white stripe. The diamond preferential lane symbol (as designated in the TMUTCD) shall be located immediately after each intersection to inform turning motorists of the restricted nature of the lane.

Horizontal Alignment

The criteria for horizontal alignment are intended to provide safe and comfortable vehicle operations at normal travel speeds, accommodate access to adjacent properties, and provide adequate operating sight distances.

Horizontal Curves

Minimum radii of curvature for the different street classifications and design speeds are shown in Table VI. These are based on free flowing traffic consisting of typical automobiles operating under poor weather conditions. Curve design on residential streets and thoroughfares should also consider intersections, bridges, and locations involving a high number of turning movements and topographic conditions.

Horizontal Tangents

Horizontal curves shall be separated by tangents. Refer to Table VI for minimum tangent calculations for all street classifications.

Vertical Alignment

The criteria for vertical alignment are intended to provide safe and comfortable vehicle operations at normal travel speeds, accommodate access to adjacent properties and provide adequate storm drainage surface flows.

The minimum grade for streets with curbs and gutters is 0.6%. Valley gutters are not permitted at the intersection of streets with a classification of major collector or arterial. Where valley gutters are permitted for intersection drainage, the minimum grade is 0.6% for concrete gutters. Additionally, when used at intersections, valley gutters shall parallel the major street or the through street of the intersection. Valley gutters which cross streets at any location other than at the intersection are not allowed except where special design is approved by the City Engineer (i.e. low flows or outfall problems).

The maximum street grade for alleys and residential streets is 10%. The maximum grade for all other streets is 6%. Steeper grades may be approved by the City Engineer for short distances where required by topographical features or

restricted alignment.

At intersections, the grades of the intersecting streets should be not more than plus or minus 2% within the first twenty-five feet of the intersecting curb line to provide a safe approach sight distance and accessible routes per the Texas Accessibility Standards (TAS) and the Americans with Disabilities Act (ADA). In unusual circumstances, approach grades of up to 8% on one of the intersecting streets may be considered by the City Engineer.

Vertical Curves

When the algebraic difference in intersecting longitudinal street grades exceeds one of the following,

- 1.0% <= 30mph (Residential)
- 0.8% <= 40mph (Collector)
- 0.5% <= 55mph (Arterial)

a parabolic vertical curve is required. The length of vertical curves will be determined by the minimum safe stopping distance for the specified design speed and is calculated by the formula:

$$L = KA$$

where : L is the length of vertical curve in feet
A is the algebraic change in longitudinal grade expressed in percent (%)
K is a constant which can be found in Table V

Super-elevation

Super-elevation shall be designed for arterial streets using the following formulas:

$$e = \frac{V^2}{15R} - f \quad \text{or} \qquad R = \frac{V^2}{15(e+f)}$$

where: e = rate of super-elevation (feet per foot)
(max value = 6%)
V = vehicle design speed (mph)
(Use 55 mph for major arterials, 45 mph for minor arterials)
f = side friction factor
(Use f = 0.130 for V=55 mph)
(Use f = 0.145 for V=45 mph)
R = radius of curve (feet)

INTERSECTION DESIGN:

Street intersections should normally be at right angles and on centerline tangents. The minimum curb return radii for all right angled intersections shall be 25 feet measured from the face of curb. Sight distances for right-angled intersections shall match the safe stopping sight distances listed in Table V.

In the event that an intersection angle varies from 90°, it shall vary by no more than 15°, and each curb return radius shall be set using the WB-50 design vehicle shown in Figure 5 with wheels clearing the curb face by 2 feet.

Offset intersections with spacings less than as shown in Table I are not permitted.

TABLE I
MINIMUM CENTERLINE DISTANCE BETWEEN INTERSECTIONS

STREET COMBINATION	DISTANCE (feet)
Residential – Residential	125
Residential – Collector	125
Minor Collector – Minor Collector	175
Major Collector – Minor Collector	Adjacent – 235 Opposite – 300
Collectors – Arterials	1000

The gutter and centerline grades of intersecting streets should be set so as to produce no more than a 2% change in grade in any direction of vehicular travel across an intersection. Storm drainage inlets shall be located outside of the intersection curb returns and should be designed to minimize the volume of storm water entering an intersection.

Intersections shall also have adjacent visibility triangles kept free of obstacles as outlined by the latest edition of AASHTO's "*A Policy on Geometric Design of Highways and Streets*". Obstacles prohibited include vegetation, entry signage, structures, buildings, etc. Public use facilities required to be at intersections such as fire hydrants, traffic signage, utility structures, etc. are exempted.

Additional design information and details shall be as published by AASHTO.

Additional right of way will be required at intersections of arterials with collectors and other arterials to allow for right turn lanes and/or dual left turn lanes. Additional right of way may be required at intersection with major collectors with other major collectors or arterials.

MEDIANS:

The use of medians will be determined either by the City or by the developer. They shall not be less than 15 feet in width as measured from back-of-curb to back-of-curb. Sheltered left turn lanes must be at least 10 feet in width with minimum storage length and approach taper determined by the included chart. Medians shall be aesthetically pleasing with bricks, stamped concrete, or landscape. Landscaped medians are considered a "special design" and plans addressing plant materials, irrigation, drainage and impact on adjacent pavement must be submitted.

TABLE II
MINIMUM LENGTH OF LEFT-TURN LANES

STREET CLASSIFICATION	MINIMUM STORAGE LENGTH	APPROACH TAPER LENGTH
LOCAL (all)	50 ft.	100 ft.
COLLECTOR (rural or minor)	80 ft.	100 ft.
COLLECTOR	100 ft.	180 ft.
ARTERIAL (all)	200 ft.	200 ft.

Optimally, median openings will be spaced, at a minimum, every 1000 feet. The City can approve additional median openings, but in no case should an opening be closer than 400 feet to another opening or to a street intersection. Maintenance of the medians will be on a case by case basis and approved by the City Engineer.

Additional design information and details shall be as published by AASHTO.

SIDEWALKS:

Sidewalks shall be a minimum of 4 feet in width (located 4 feet from the back of curb) in single family and duplex residential areas, a minimum of 5 feet in width (located 3 feet from the back of curb) in all other areas or along streets classified as collectors or higher, and a minimum of 6 feet in width when located adjacent to the back of curb. When approved by the City, sidewalk alignments may be varied to accommodate landscaping and avoid trees or other obstructions in the standard sidewalk location. In all circumstances, a minimum clear pedestrian width of 4 feet shall be provided.

Designs for the construction of sidewalks shall meet current TAS and ADA standards. Ambulatory ramps at street intersections shall be cast with full depth integral color or stain in the tread way. Ambulatory ramps adjacent to colored sidewalks shall be cast with plain grey in the treadway.

Concrete driveways, regardless of length or slope, will contain a minimum 4 foot wide sidewalk section with a cross slope as shown on the standard detail which aligns with sidewalk approaches.

PAVEMENT STRUCTURE:

Pavement structure for urban streets is generally determined by the anticipated loads to be carried, the quality and strength of the paving materials used and the load bearing capacity of the underlying subgrade. This manual provides minimum criteria for both rigid and flexible pavements using generalized soil conditions applicable to coarse grained and clay soils for each street classification. These minimum criteria are shown in Table VII.

The design engineer shall visit the site and make soil tests to determine the appropriate subgrade preparation and pavement design.

If an alternate pavement design is proposed, the engineer should discuss with the City such alternate ideas and methodology. The engineer shall base the pavement thickness designs on actual soil analyses and use the current AASHTO pavement thickness design methods. Specific pavement thickness designs submitted for approval must be accompanied by soils testing reports to fully support the assumptions of the procedure being used. Parameters based on general soil classifications will not be permitted. The City reserves the right to deny alternate designs.

When underground utility conduits or storm sewers are constructed or reconstructed in open trenches beneath new pavement, the trenches must be backfilled over the required bedding and compacted up to the bottom of the subgrade as shown in the City's Standard Construction Details.

CURBING: Rural streets are not required to have curbs. All other streets shall have 6-inch raised curb. Residential streets may have a standard lay-down curb. All lay-down curb designs must be accompanied with drainage design calculations. Sidewalks shall not be installed adjacent to lay-down curb.

Curbing for rigid pavements shall conform to the cross sections as shown in the City's Standard Construction Details and shall be poured monolithically with the paving or be doweled in.

STREET CROWNS: Street crowns shall be at the centerline of pavement and will be set by a straight 3% cross-slope upward from the edge of the gutter. Offset crowns may be used in unusual circumstances. No streets, with the exception of alleys, will be allowed to have center drains.

ETJ STREETS: Concrete streets are not allowed in developments in the ETJ.

Utilities parallel to the roadway in ETJ developments shall not be located within rights of way.

ENTRANCE ISLANDS: Entrance islands will be considered as "special designs" and will be reviewed on a case by case basis. A homeowners association is required to provide maintenance of landscaping and improvements contained in entrance islands.

SIGNAGE:

Regulatory Signage:

All regulatory signage shall be in compliance with the TMUTCD. The City will install all regulatory signage.

Street Name Signs

Street name signs will be installed by the City. The cost of street signs will be per local regulations.

Decorative Signage

Special sign poles are allowed but the installation must meet State safety requirements.

Other Signs

All other signs will be regulated by the sign ordinance.

STREETSCAPE:

Handrails

The design shown in the Standard Sidewalk Details will be used wherever a vertical drop of 8 inches or greater within 3 feet of the walkway exists.

Street Furniture

Street furniture will be in accordance with the standards adopted in the overlay district, where one exists.

Brick Pavers

Brick pavers may be used on sidewalks and on streets at crosswalks or in intersections. Brick pavers in streets and sidewalks are to be placed on top of full depth concrete pavement. The color and texture of brick pavers will be in accordance with the standards adopted in the overlay district, where one exists.

Brick pavers shall be used on medians less than 4 feet in width or within 50 feet of median noses. Brick pavers in medians will be installed on top of a sand bed or base material instead of full depth pavement.

Patterned Colored Concrete

Patterned colored concrete may be used on sidewalks, crosswalks, in intersections, or in medians. Color should be integral to the concrete or by stain.

GATED NEIGHBORHOODS:

No gates are allowed on public streets. A homeowners association is required for maintenance of gates. Access shall be provided for emergency services, utility and solid waste services and for pedestrians.

STREETLIGHTS:

Street lighting will be included in all new developments. The pole lamp and fixture specifications as well as the cost for street light installation will be per local codes. Street lights should be placed at all intersections, at the end of all cul-de-sacs and at a minimum spacing of 300 feet.

BICYCLE FACILITIES:

All bicycle facilities, including but not limited to, bike routes, bike lanes, and bike paths shall be designed in accordance with the most current AASHTO guidelines.

TABLE III - MINIMUM GEOMETRIC DESIGN CRITERIA FOR NEW CONSTRUCTION

	Alley	Residential	NTD Residential Streets[1]	Rural[4] Residential	Rural[4] Collector	Minor Collector/ Commercial Street	Major Collector	Minor Arterial Undivided	Minor Arterial Divided	Major Arterial
ROW[2]	24’	50’	50’	70’	100’	60’[7]	80’	100’	100’	120’
Pavement Width[3]	12’	27’	24’	24’	30’	38’	54’	70’	72’ or 78’	96’
Traffic Lanes	N/A	2	2	2	2	2 or 3	3 or 4	5	4	6
Lane Width[5]	N/A	N/A	N/A	12’	15’	12’	12’ or 12’/15’[5]	12.5’/15’[5]	12.5’/15 or 12.5’/12’[5]	12.5’/12’/ 15’[5]
Curb	None	Laydown or standard	Laydown or standard	None	None	Standard	Standard	Standard	Standard	Standard
Shoulder Width	N/A	N/A	N/A	2 @ 3’ Ea[6]	2 @ 3’ Ea	N/A	N/A	N/A	N/A	N/A
Left Turn Lane Width	None	None	None	None	None	Permitted (14’)	Permitted (16’)	Permitted (15’)	None	None
Parking	None	Permitted	One Side Only	None	None	Permitted w/out bike lanes	None	None	None	None
Raised Medians	None	None	None	None	None	None	None	None	17’	17’
Sidewalks	None	Per local Subdivision Ordinance	Per local Subdivision Ordinance	None	None	Both	Both	Both	Both	Both
Bike Lanes	N/A	N/A	N/A	N/A	N/A	Permitted per bicycle plan	Permitted per bicycle plan	N/A	Permitted per bicycle plan	N/A

NOTES:

- Cul-de-sacs on residential street shall have a 50’ ROW radius with a 40’ pavement radius. All other cul-de-sac streets shall have a min. 60’ ROW radius with a min. 50’ pavement radius. Temp. T turnarounds, in accordance with the local fire code, will only be allowed under circumstances when no other option is viable and with prior approval.
- At all intersecting street rights-of-ways, provide a minimum 25’ ROW radius.
- Additional easements may be required parallel to the street right-of-way for utilities if necessary.

[1] No more than 24 lots between cross streets. Allowed in single family developments only.
[2] Right of Way widths listed herein are a minimum and additional right of way may be required. At intersections of collector to collector streets or greater, additional row will be provided for dual left or right turn lanes as required by traffic impact study or requested by the City.
[3] Pavement widths are measured from back of curb to back of curb or from the edge of pavement to edge of pavement where there is no curb.
[4] Rural sections shall only be used where allowed by local zoning. Rural collector streets will not be required to have 16’ easements parallel to right-of-way within ETJ limits and will not be allowed within city limits.
[5] Wider lanes required on outside lanes only.
[6] Rural Residential Shoulders shall be asphalt primed.
[7] A 5 foot easement will be required on either side of right-of-way.

TABLE IV
STREET CLASSIFICATION DEFINITIONS

ALLEY: A minor public right-of-way which provides a secondary means of vehicular access to abutting property and which is used primarily for vehicular traffic to the rear or side of properties which otherwise abut on a public street. Parking is not allowed on alleys.

COMMERCIAL STREET: A street which primarily serves commercial or multi-family development. Commercial streets shall be built to at least Minor Collector standards.

MAJOR ARTERIAL STREET: A street which carries high volumes of vehicular traffic (in the general range of 20,000 VP to 60,000 VP) and which is intended to move traffic in, out or around the City.

MINOR ARTERIAL STREET: A street which carries high volumes of vehicular traffic (in the general range of 5,000 VP to 30,000 VP) and which is intended to move traffic around the City.

MAJOR COLLECTOR STREET: A street which primarily serves vehicular traffic (in the general range of 5,000 to 10,000 VP) from residential streets and minor collectors to arterials. A collector may also provide very limited access to abutting properties if approved by the City.

MINOR COLLECTOR STREET: A street which primarily serves vehicular traffic (in the general range of 1,000 to 5,000 VP) from residential streets to collectors or arterials. A minor collector may also provide limited access to abutting properties if approved by the City. Additionally, the streets identified as collectors on the Thoroughfare Plan may be designed as minor collectors only if approved by the City.

NEO-TRADITIONAL DESIGN (NTD) RESIDENTIAL STREET: A street which primarily serves vehicular traffic to abutting single family residential properties where narrow, more curvilinear streets are desired. Parking is only allowed on one side of the street and block length is limited.

RESIDENTIAL STREET: A street which primarily serves vehicular traffic to abutting residential properties. A residential may also provide limited access to commercial properties if approved by the City.

RURAL RESIDENTIAL STREET: A street in the ETJ of the City which primarily serves vehicular traffic to abutting residential properties. A rural residential may also provide limited access to commercial properties if approved at the time of platting by the City and County. Construction and maintenance of the rural residential streets are generally under the jurisdiction of the County. Rural street sections are allowed inside the city limits in areas with appropriate zoning and lot size. Refer to the local zoning ordinance for guidance.

RURAL COLLECTOR STREET: A street in the ETJ of the City which primarily serves vehicular traffic from residential streets to arterials. A rural collector may provide limited access to abutting residential properties if approved at the time of platting by the City and County. Construction and maintenance of the rural collectors are generally under the jurisdiction of the County.

TABLE V
MINIMUM GEOMETRIC CRITERIA FOR STOPPING SIGHT DISTANCE

STREET CLASSIFICATION	DESIGN VEHICLE	DESIGN SPEED (mph)	STOPPING SIGHT DISTANCE (ft)	MIN. "K" [1]	
				CREST	SAG
MINOR COLLECTOR	SU	35	250	29	49
RURAL COLLECTOR & MAJOR COLLECTOR	SU	40	305	44	64
MINOR ARTERIAL	WB-50	45	360	61	79
MAJOR ARTERIAL	WB-50	By Design	By Design	By Design	By Design

NOTES:

- Sight distance at street intersections shall be provided in accordance with the latest edition of AASHTO's "*A Policy on Geometric Design of Highways and Streets*" measured 10' from the edge of the intersecting street.

[1] If intersecting grades result in a "K" value less than that shown, the minimum vertical curve length shall be equal to 3xDesign Speed.

TABLE VI
MINIMUM GEOMETRIC CRITERIA FOR HORIZONTAL CURVATURE

Street Classification	Design Vehicle	Design Speed (mph)	Des. Max. Rate of Super-elevation (%)	Min. Center-line Radius (ft)	Max Tangent Between Reverse Curves	Min. Tangent Between Reverse Curves (ft)	Max. Relative Edge Slopes for Super Transition [1] (ft/ft)
Rural Collector	SU	40	N/A	575	N/A	By Design	N/A
Minor Collector	SU	35	N/A	430	N/A	By Design	N/A
Major Collector	SU	40	N/A	575	N/A	By Design	N/A
Minor Arterial	WB-50	45	6	675	N/A	By Design	1:200
Major Arterial	WB-50	By Design	6	By Design	N/A	By Design	1:225

[1] Super-elevation transition is to be accomplished 2/3 outside of the horizontal curve and 1/3 within the curve. The minimum tangent between successive horizontal curves should be designed such that proper super-elevation transitions can be effected.

Example for calculating super-elevation and minimum tangent between successive curves:

Given: 5-lane minor arterial with 12-foot lanes and a 14-foot TWLTL. Typical section is rooftop crown with 2% cross slopes. 675-foot curve left followed by a 675-foot curve right. Super-elevation rotation is about center of road.

6% maximum super-elevation required for the minimum curves given.

high side max. relative vertical transition = (0.06-(-0.02)) x (12'+12'+ (14'/2)) = 2.48 feet

horizontal transition required to effect super-elevation = 2.48' x 200 (from last column in above table) = 496 feet

2/3 within tangent = 330 feet; 1/3 within curve = 166 feet

low side max. relative vertical transition = (0.06 - 0.02) x (12'+12'+ (14'/2)) = 1.24 feet

horizontal transition required to effect super-elevation = 1.24' x 200 (from last column in above table) = 248 feet

2/3 within tangent = 165 feet; 1/3 within curve = 83 feet

Therefore, the minimum tangent length required between these two curves is 495 feet, or 330 feet + 165 feet.

TABLE VII
MINIMUM PAVEMENT THICKNESS CRITERIA

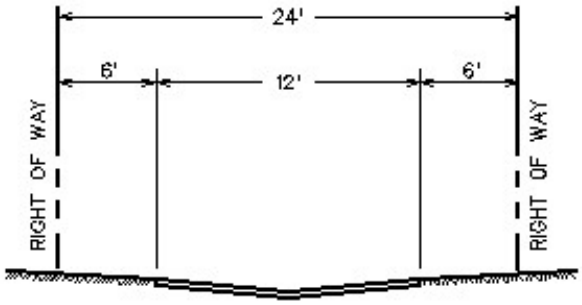
FLEXIBLE PAVEMENTS			
STREET CLASSIFICATION	SUBGRADE TREATMENT	BASE MATERIAL	SURFACE TREATMENT
RESIDENTIAL	6-in Lime-Stab.	6-in. Limestone, 6-in. Cement Stabilized Base or 4-in. HMAC	2-in. HMAC
MINOR COLLECTOR	6-in Lime-Stab.	8-in. Limestone, 8-in. Cement Stabilized Base or 5-in. HMAC	2-in. HMAC
COLLECTOR & ARTERIAL	Design based upon Geotechnical Report, but not less than pavement structure shown for a minor collector.		

RIGID PAVEMENTS		
STREET CLASSIFICATION	SUBGRADE TREATMENT	CONCRETE PAVEMENT
RESIDENTIAL (includes alleys)	6-in Lime-Stab.	6-in.
COLLECTOR	6-in Lime-Stab.	8-in.
ARTERIAL	Design based upon Geotechnical Report, but not less than pavement structure shown for a collector.	

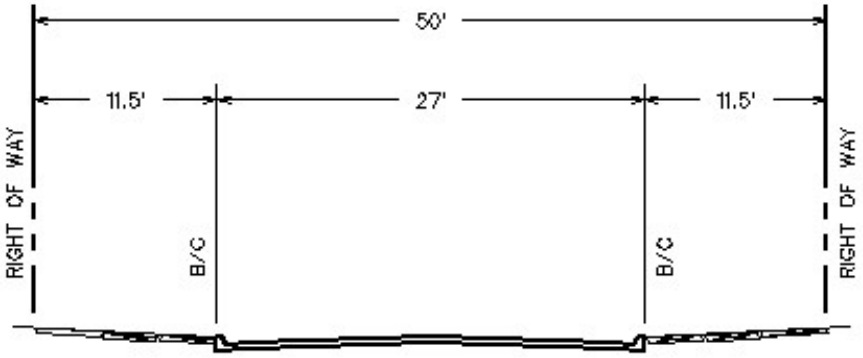
NOTE:

- Lime stabilization is the most commonly used for this area, if other types of stabilization are desired, please submit information.

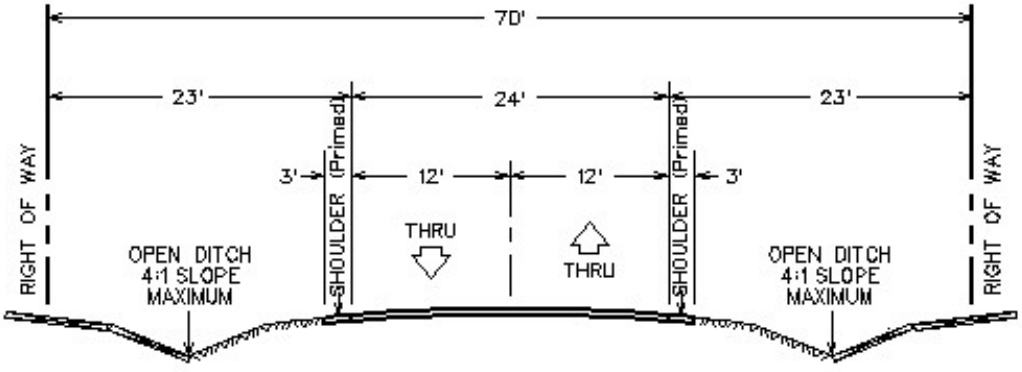
FIGURE 1
RESIDENTIAL STREET SECTIONS



ALLEY

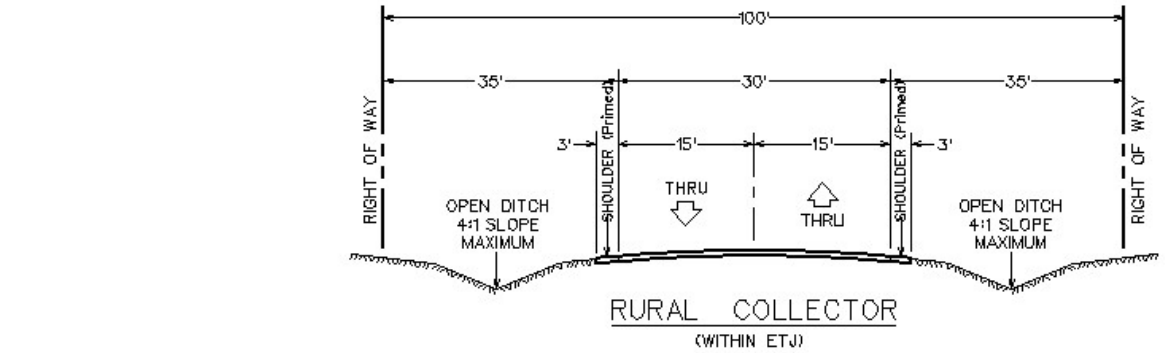


RESIDENTIAL

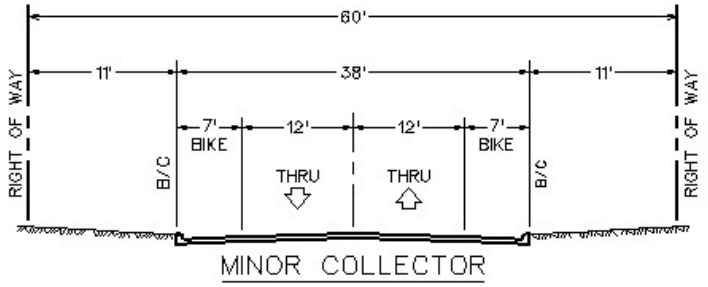


RURAL RESIDENTIAL

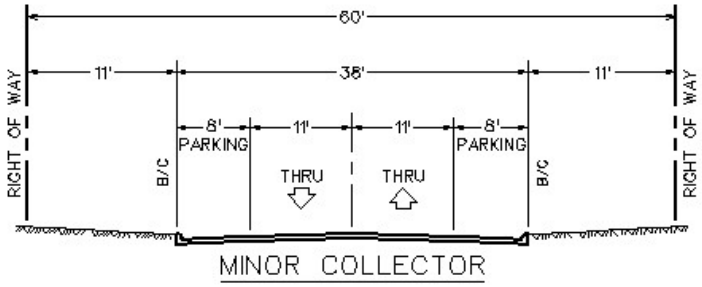
FIGURE 2
COLLECTOR STREET SECTIONS



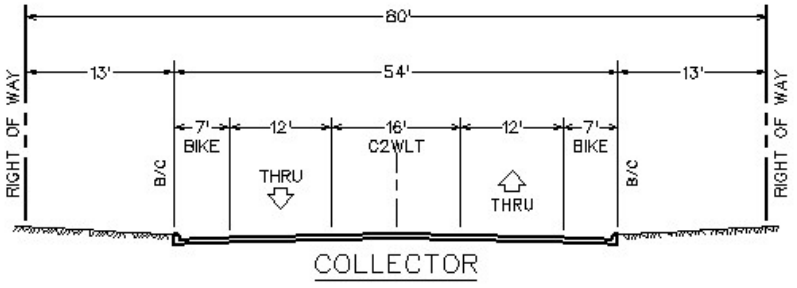
RURAL COLLECTOR
(WITHIN ETJ)



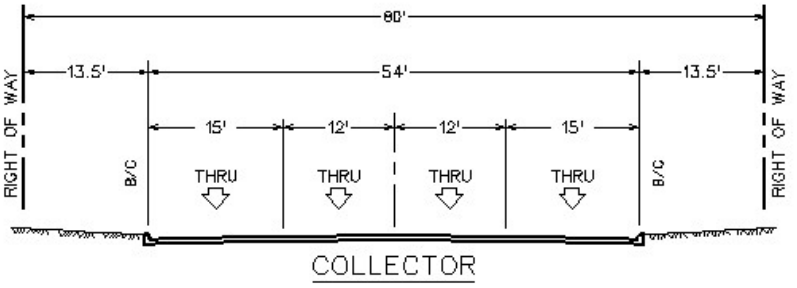
MINOR COLLECTOR



MINOR COLLECTOR

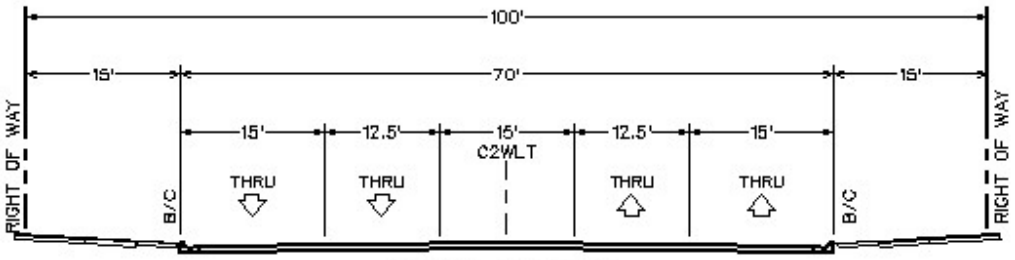


COLLECTOR

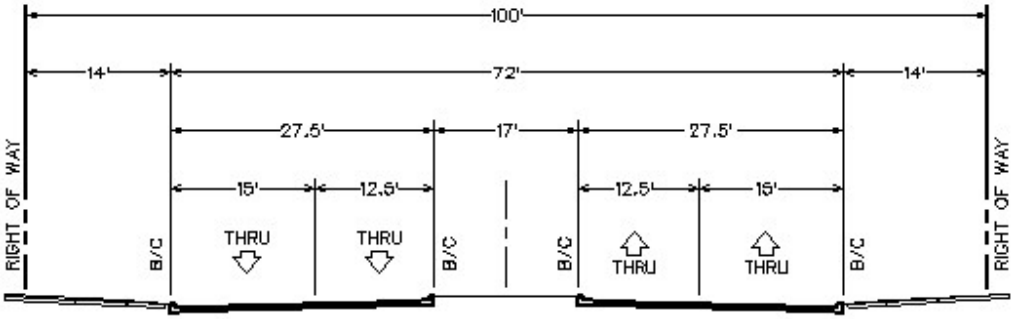


COLLECTOR

FIGURE 3
ARTERIAL STREET SECTIONS



MINOR ARTERIAL



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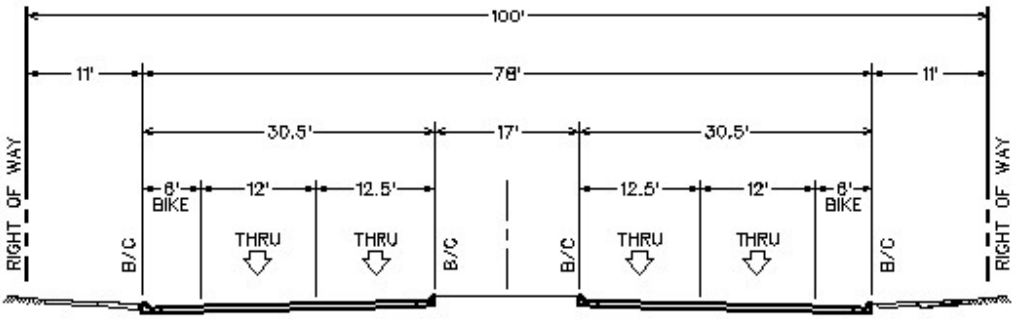
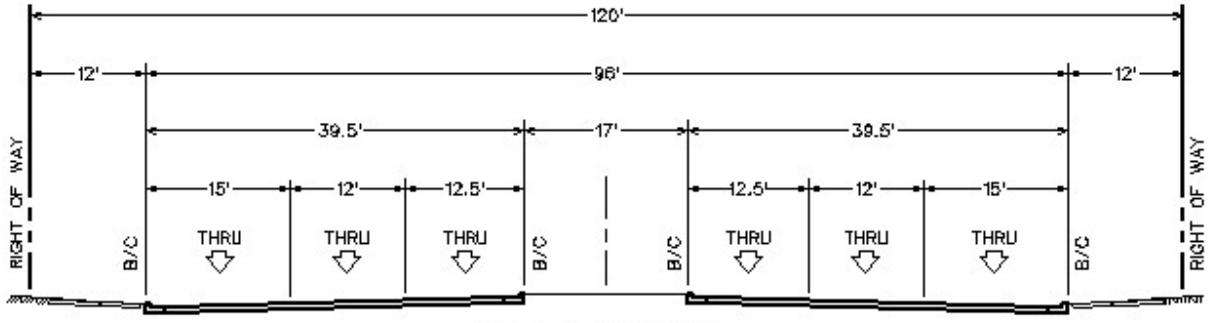
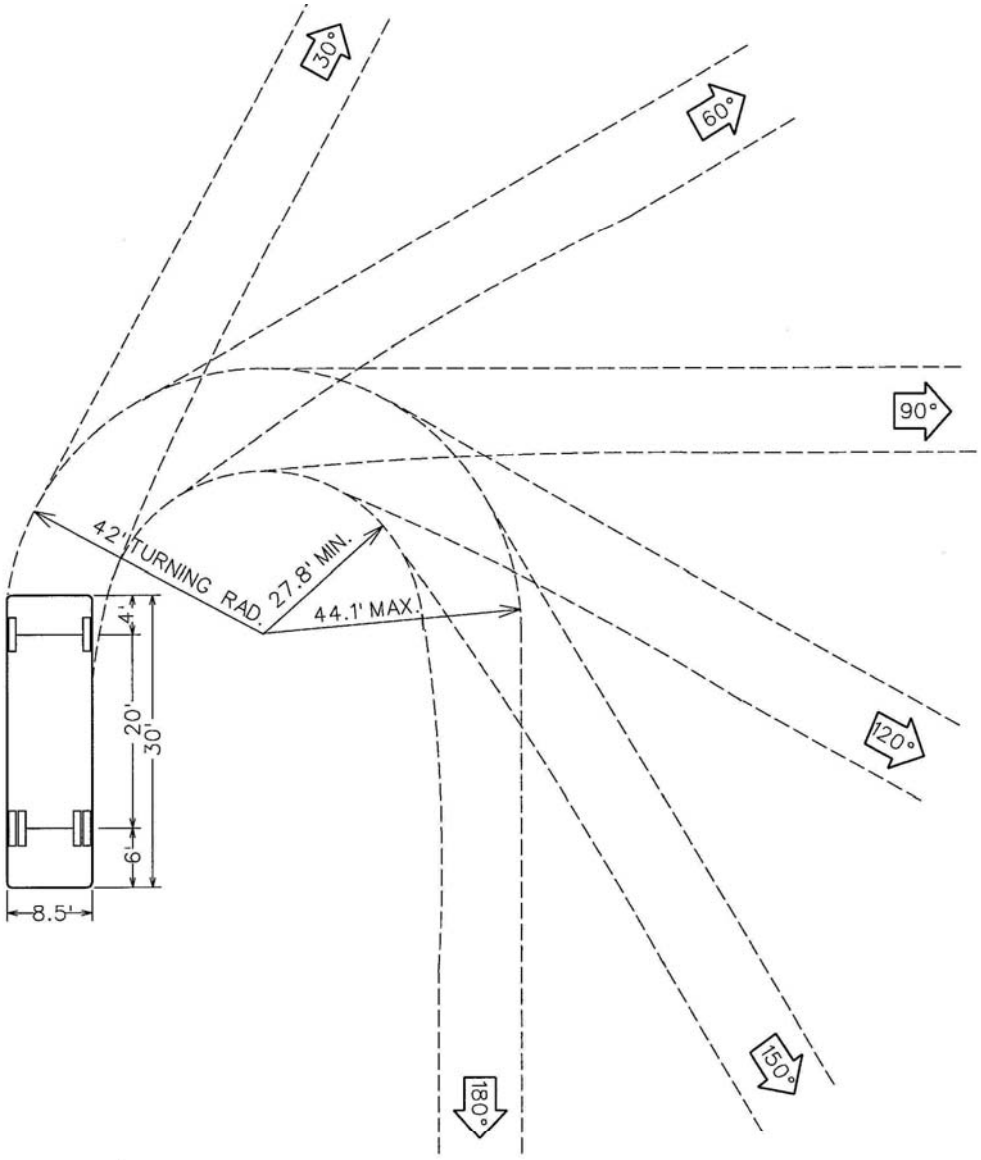


MINOR ARTERIAL



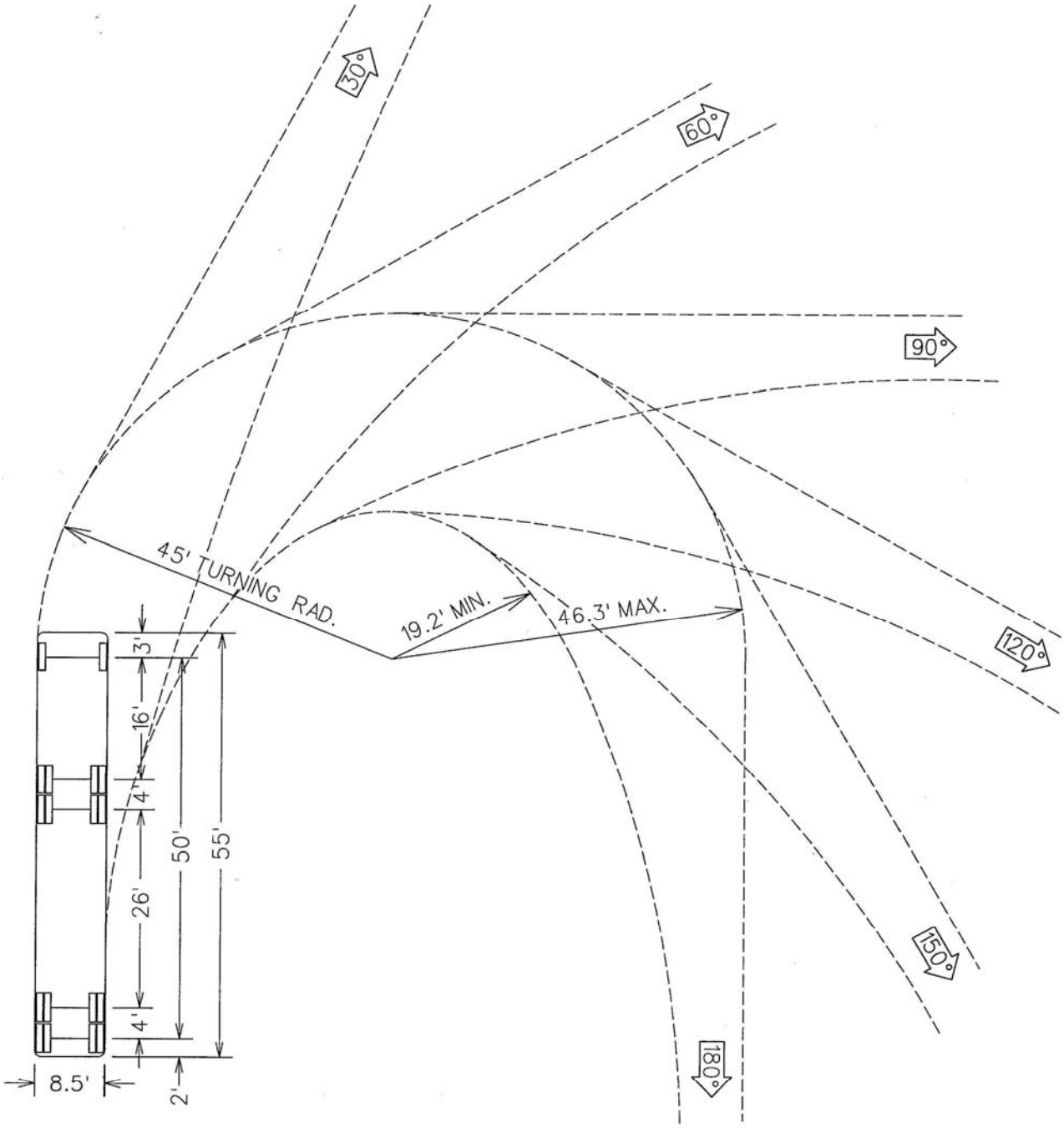
MAJOR ARTERIAL

FIGURE 4
SINGLE UNIT TURNING DESIGN TEMPLATE



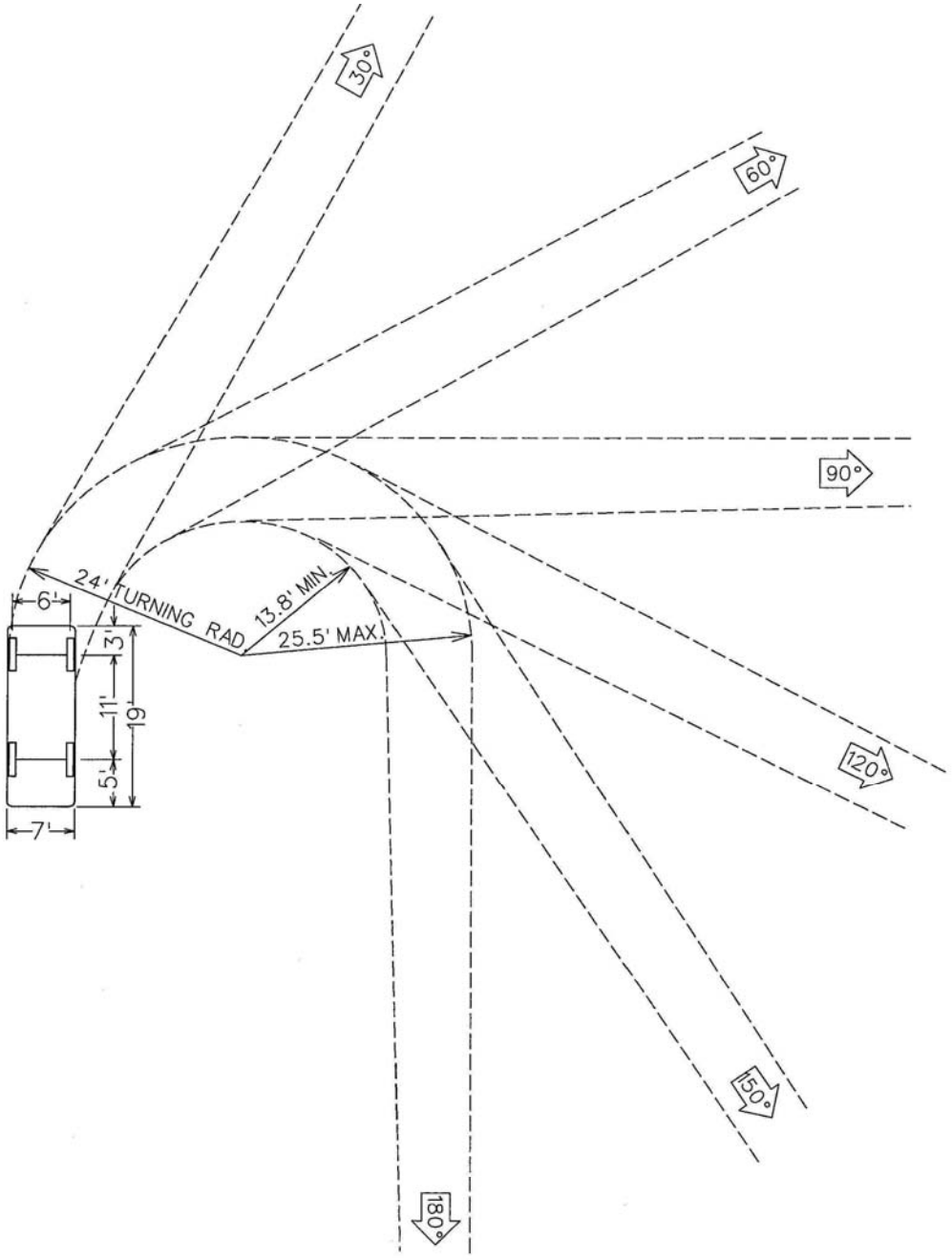
Radius = 42'

FIGURE 5
WB-50 TURNING DESIGN TEMPLATE



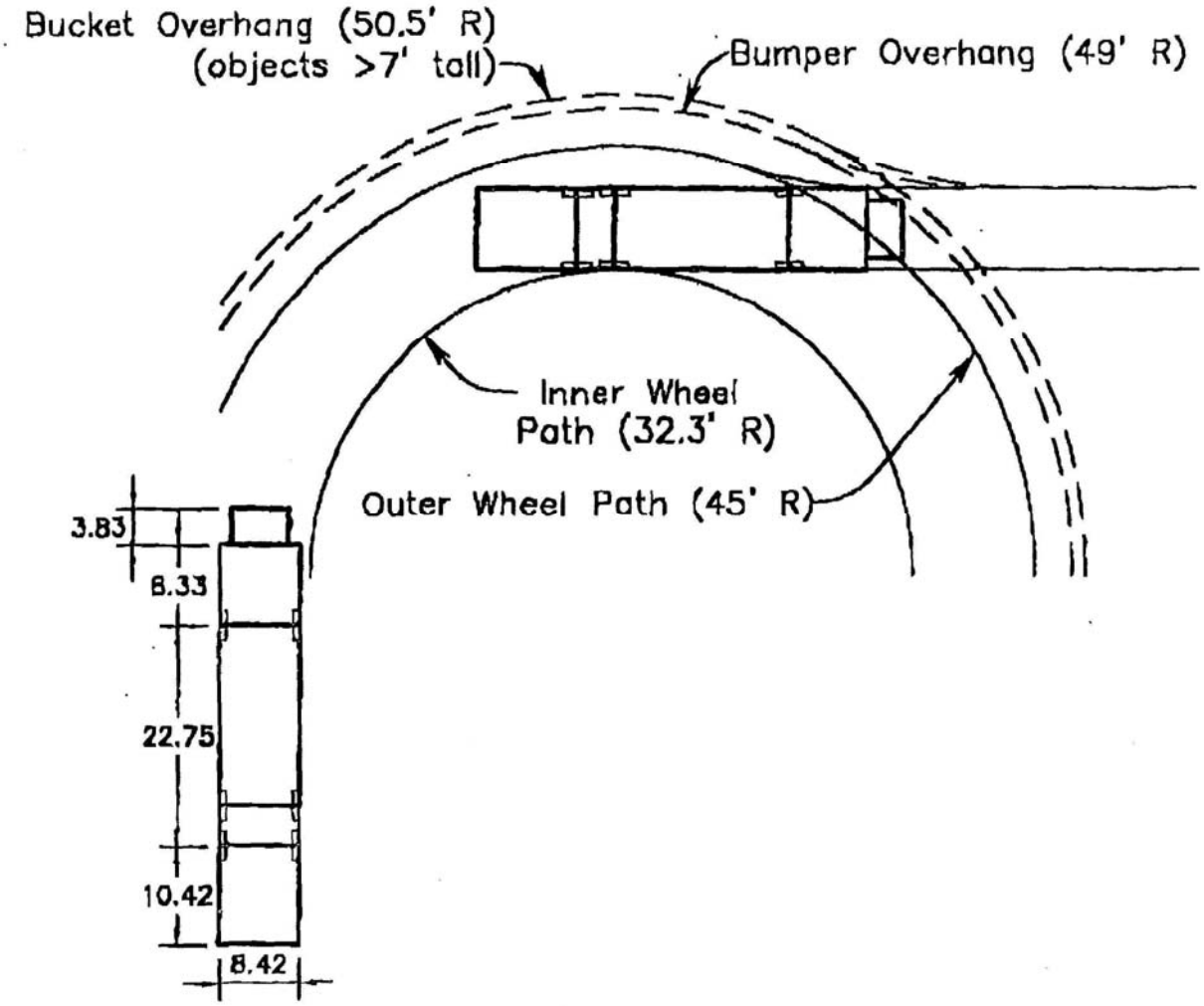
Radius = 45'

FIGURE 6
PASSENGER CAR TURNING DESIGN TEMPLATE



Radius = 24'

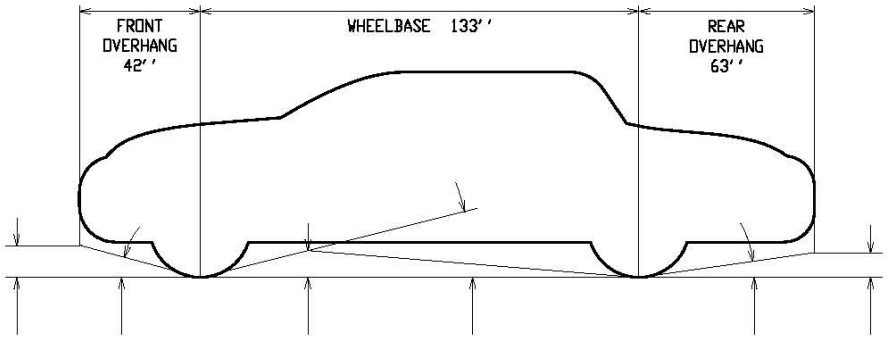
FIGURE 7
FIRE LADDER TRUCK
TURNING DESIGN TEMPLATE



Radius = 45'
Scale = 20'

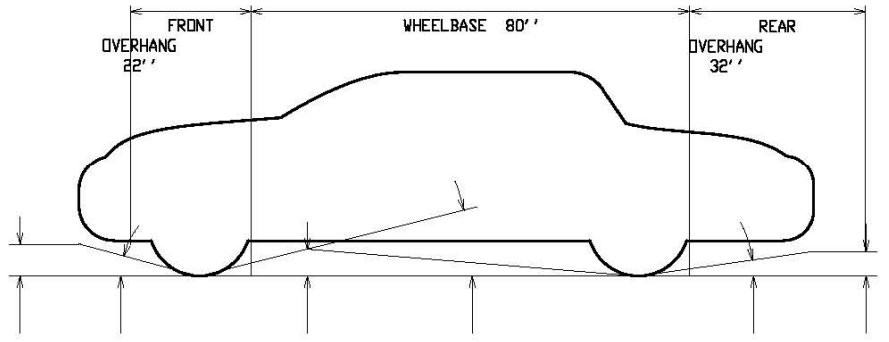
FIGURE 8

CLEARANCE DIMENSIONS FOR COMPOSITE VEHICLES



FRONT CLEARANCE	APPROACH ANGLE	CENTER CLEARANCE	RAMP ANGLE		DEPARTURE ANGLE	REAR CLEARANCE
11.0''	15°	4.0''	7°	*NORMAL LOAD*	9°30'	10.6''
7.0''	9°30'	2.5''	4°15'	*FRONT DRIVE*	10°45'	12.0''
11.9''	16°	2.5''	4°15'	*REAR JOUNCE*	5°45'	6.2''
8.0''	10°45'	1.0''	1°45'	*FULL JOUNCE*	7°	7.6''

COMPOSITE LONGEST VEHICLE: CLEARANCE DIMENSIONS UNDER VARIOUS CONDITIONS



FRONT CLEARANCE	APPROACH ANGLE	CENTER CLEARANCE	RAMP ANGLE		DEPARTURE ANGLE	REAR CLEARANCE
5.8''	15°	4.9''	14°	*NORMAL LOAD*	8°	4.5''
3.3''	8°30'	3.9''	11°	*FRONT DRIVE*	9°30'	5.3''
6.3''	16°	3.9''	11°	*REAR JOUNCE*	3°	1.7''
3.8''	9°45'	2.9''	8°30'	*FULL JOUNCE*	9°	2.5''

COMPOSITE SHORTEST VEHICLE: CLEARANCE DIMENSIONS UNDER VARIOUS CONDITIONS